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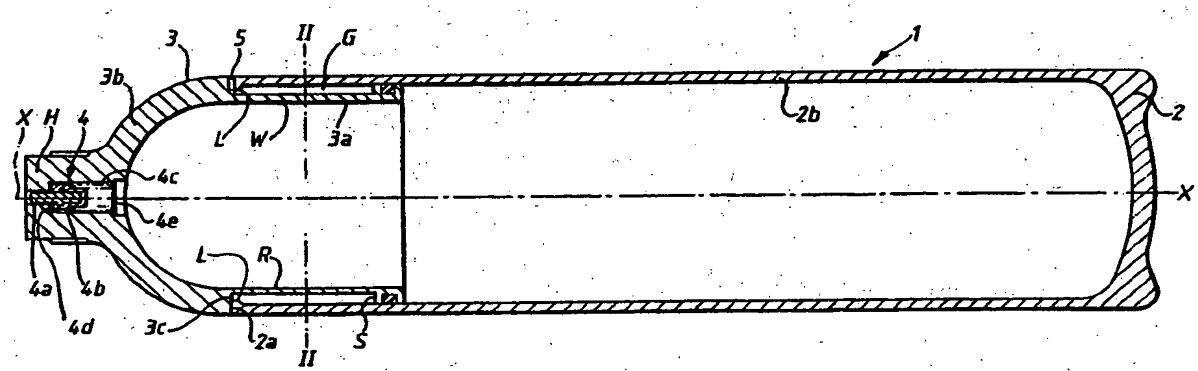

(57) Abstract

A fluid container (1) for containing a fluid under pressure, comprising a tubular member (2) closed by a closure member (3), said closure member (3) having a tubular part (34) extending generally axially within the tubular member (2) to form at least one peripheral space (G) between the closure member (3) and tubular member (2), the space being sealed from the inside of the container and having at least one vent passage (5) leading from the space to outside the container (1). This construction enables radial pressure inside the container (1) to assist in providing a strong joint. The container (1) may include a pressure-relief safety device in the form of at least one frangible wall portion (R) of said tubular part (3A), said frangible wall portion (R) being arranged to break in the event that the pressure in the container (1) exceeds a predetermined safety limit.

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FLUID CONTAINER

This invention relates to a fluid container in which the fluid may be contained under pressure.

Such containers are known, for example, for storing and dispensing carbon dioxide for a variety of purposes. Such fluid containers tend to be disadvantageous in certain respects and some of these disadvantages are discussed in PCT Patent Applicaton No. WO 82/03441, to which reference is made. Although it is believed that embodiments of the invention described in application WO 82/03441 overcome certain disadvantages assocated with the prior art, it is now believed that these designs can be significantly improved in various respects.

Thus, the present invention provides a fluid container for containing a fluid under pressure comprising a tubular member closed by a closure member, said members being joined together by the pressure of the fluid acting radially outwardly on the closure member.

According to the present invention there is further provided a fluid container for containing a fluid under pressure, comprising a tubular member closed by a closure member, said closure member having a tubular part extending generally axially within the tubular member to form at least one peripheral space between the closure member and tubular member, the space being sealed from the inside of the container and having at least one vent passage leading from the space to outside the container.

The container is preferably provided with a pressure-relief safety device in the form of at least one frangible wall portion of an inner wall arranged generally axially of the container, said

wall portion being arranged to break in the event that the pressure in the container exceeds a preset safety limit. The safety device thus acts to protect the seal between the tubular and closure members against ultimate failure. By so doing the invention may be described as a "pressure activated safety joint" between the two above members.

By this aspect of the present invention it is possible for the safety device to mimic more closely the tubular member generally without undesirable approximations due to scale effects as tends to be the case with known bursting safety devices.

The present invention may be applicable to refillable or non-refillable fluid containers.

The inner wall is preferably provided on a tubular part of the closure member such that a gap is defined between the frangible wall portion and the tubular member with at least one vent or passageway leading from said gap to outside the container. Said tubular member may be cylindrical. Preferably, the diameter of said inner wall is of the same order as the diameter of said tubular member to mimic more closely the behaviour of the tubular member under pressure.

The material of the tubular member may be the same as the material of the closure member, for example plastics or metal, or the material of the closure member may be different from that of the tubular member. The closure member may be permanently attached to the tubular member for example by friction welding or may be mechanically interlocked therewith.

In one embodiment of the present invention the tubular part of the closure member is generally

coaxial with the tubular member and has at least one localised region having a wall thickness which is thinner (about 2.5 to 3.5 mm thick for a plastics material and 1 to 2 mm thick for metal) than the remainder of the tubular part. In this way, under an increasing pressure in the fluid container the thin wall portion (frangible wall portion) is able to bulge into the annular gap between the tubular member and said tubular part until it breaks and allows the pressure (and fluid from the container) to vent to atmosphere.

The closure member may have a head (the closure member may have a dome top with said head) containing a valve such as a poppet or aerosol valve or said head may instead include a frangible wall which is designed to be pierced in order to expel the contents (e.g. in the manner of a SPARKLETS™ bulb).

The closure member may be of a modular construction allowing the selection of different types of valves or frangible walls to be used therewith and utilizing the same tooling for refillable and non-refillable containers.

The closure member may have an annular shoulder attached to said tubular part (for example by welding) with lands being formed on said tubular part to thereby restrain the closure member from being propelled out of the tubular member in the event of said shoulder breaking away from the tubular part.

The tubular member may be formed with an annular lip to retain the closure member to the tubular member or the tubular member may be swaged or crimped to the closure member. The closure member may be screwed to the tubular member.

The closure member may be retained to the tubular member by a locking or retaining ring having an inclined edge which engages a matching angled bead on the closure member. The angle of the bead may be between 5° and 50° to the radial plane, preferably between 10° and 30°, for instance 20° to 25° to said radial plane. The retaining ring may be seated in an inner groove on the tubular member some distance in from the open end thereof and the closure member may be prevented from being expelled from the tubular member by a "wedging" action provided by the locking ring.

The tubular part of the closure member is, preferably, shaped at one end to receive peripheral sealing means (usually in the form of an O-ring seal) to seal the closure member to the tubular member.

The closure member may comprise an outer shell (e.g. of plastics) carrying an inner metal lining sealed thereto. One or more local regions of the outer shell are removed to provide one or more gaps between the lining and the wall of the tubular member. In this manner, under pressure, the metal lining can expand into the gap or gaps in the outer shell until the lining bursts allowing pressure to be vented via vents leading from said gap or gaps to outside the container. Advantageously, the design obviates the need for high-strength plastics to be used for the closure member, which would otherwise be enquired, if the closure member were to be entirely of plastics.

The closure member may be provided with a valve (e.g. aerosol valve) of simplified construction. The closure member may be shaped to receive a valve member (e.g. valve poppet), spring means and a retaining plate (where the closure member

includes an inner lining said lining may function as the retaining plate), with said valve parts being introduced into place from inside the closure member. In this manner, the closure member itself may provide the valve housing. The costs of providing such a valve are greatly reduced compared with conventional designs. Additionally, containers of comparable capacity can be made to a shorter overall length due to the design of the valve.

The container may be of a modular construction and assembled from a variety of preselectable tubular members, and two-part closure members including different valve or pressure safety components.

According to the invention there is further provided a fluid container for containing a fluid under pressure, comprising a tubular member and a closure member wherein the closure member includes a displaceable valve plug having an orifice of chosen size and a forward portion adapted to fracture in the event that the pressure in the container exceeds a threshold limit, the valve plug being adapted to close upon fracture of the forward portion to allow controlled discharge of the contents of the container.

In a further aspect, the invention provides a fluid container for containing a fluid under pressure, comprising a tubular member which receives a closure member, said container being provided with a pressure-relief safety device in the form of at least one frangible wall portion of an inner wall arranged generally axially of the container, said wall portion being arranged to break in the event that the pressure in the container exceeds a preset safety limit.

Other advantageous features of the fluid container will be apparent from the following specific description.

Embodiments of a fluid container in accordance with the present invention are described, by way of example only, with reference to the accompanying simplified drawings in which:

Figure 1 shows a sectional view of the first embodiment of the container;

Figure 2 shows a sectional view taken on line II-II of Figure 1;

Figure 3 shows a second embodiment of the container and is a view similar to Figure 1;

Figure 4 shows a third embodiment of the container which is a half-sectional cut-away view;

Figure 5 illustrates a fourth embodiment of the container;

Figure 6 shows a cut-away view of a fifth embodiment of the present invention;

Figure 7 shows a sixth embodiment and a method of connection of a closure member to the tubular part of the container by frictional welding; and Figure 8 shows a modified container.

Figures 1 and 2 of the drawings show a fluid container 1 comprising a body or tubular member 2 closed by a bottom (located at the right-hand end of Figure 1) and by a closure member 3 (located at the left-hand end of Figure 1).

Both the tubular member 2 and the closure member 3 are generally cylindrical. The closure member 3 has a tubular part 3a extending within the tubular member 2 a substantial amount, for example about one fifth of the length of the member 2. The closure member 3 has a dome top 3b which is normally arranged upwardly in use and is provided with a head

H which carries a centrally located poppet or aerosol valve 4 arranged on the axis X-X of the tubular member 2. An annular shoulder 3c on closure member 3 is defined at the junction of the dome top 3b and tubular part 3a and, in this example, the shoulder 3c is permanently attached to the tubular member 2 for example by friction welding the shoulder 3c to the annular end face 2a of the tubular member 2.

As will be evident from Figure 1 and Figure 2 an annular gap G is defined between the tubular part 3a and the tubular member 2. In this instance, both the tubular member 2 and closure member 3 are of metal alloy but they either or both could be of high-strength plastics or plastics coated metal if preferred. A localised region R of the tubular part 3a is of reduced thickness (see Figure 2) and is designed to burst at a particular safety pressure to allow fluid to escape from the container 1 through to atmosphere by way of three equiangularly spaced radial vents 5 leading from the annular gap G to atmosphere.The elastic modulus of the closure member is preferably substantially lower than that of the tubular member, so that radial outward pressure tends to force the members together.

Additionally, the tubular part 3a is provided at its end remote from the shoulder 3c with a thickened portion in the form of an annular end shoulder S to receive an O-ring which seals against the inside of the tubular member 2. Thus the closure member 3 provides an inner wall W coaxially arranged with the tubular member 2 and having a frangible wall portion R. In the present example the thickness of the wall portion R is 1 to 2 mm and is designed to burst at a pressure of about 2,250 p.s.i.g. (15513

kPa), the bursting pressure of the tubular member 2 being about 3,000 p.s.i.g. (20684 kPa).

When the fluid container 1 is in use the inner wall W is under pressure and as that pressure increases the frangible wall portion R tends to bulge outwardly to a more and more significant extent, into the annular gap G. The frangible wall portion R should be designed to break before touching or bearing significantly against the inside of the tubular member 2 (i.e. before traversing the annular gap G). The annular gap G will normally be at the same pressure as the surrounding atmosphere and thus the pressure relief device provided by the inner wall W effectively mimics the cylinder wall 2b of the tubular member 2. The arrangement as so far described provides a very simple safety device which operates under conditions which are more truly representative of the pressure on the cylinder wall 2b. Additionally, and advantageously, should the weld between the shoulder 3c and the edge 2a break, the closure member 3 will not be propelled out of the tubular member 2 (like a missile) because raised lands L provided inwardly on the tubular member 2 adjacent the edge 2a will engage and retain the annular shoulder S that receives the O-ring seal (as the closure member 3 is propelled to the left in Figure 1 along the axis X-X).

Although the aforesaid embodiment shown in Figure 1 has an inner wall W with one frangible wall portion R a plurality of such frangible wall portions may be provided angularly spaced around the axis X-X and in one such embodiment three equiangularly spaced frangible wall portions are provided. Providing a plurality of frangible wall portions and additionally providing a plurality of equiangularly spaced radial

vents 5 allows gas from the container to escape both at a controlled rate and in a multidirectional manner which is intended to minimise jet reaction forces.

The design of the annular gap G and vents 5 is such that the fluid pressure in the annular gap G is substantially maintained above a level below which solid phase might form from the escaping fluid; for example for liquid carbon dioxide the pressure in the gap G should be above 60.4 p.s.i.g. (416 kPa) so that solid carbon dioxide (which could block the vents preventing pressure release) does not form. Thus, the aforedescribed embodiment eliminates the need for an expensive brass valve body and burst disc assembly and the frangible wall portion R and tubular part 3a of the closure member closely mimic the cylinder wall 2b for additional safety. In effect the fluid container 1 is double-walled over part of its length with the O-ring (circumferential sealing means) providing fluid-tight sealing between the closure member 3 and tubular member 2, the annular gap G allowing room for the frangible wall portion R to expand and burst under excess pressure without bearing unduly against the cylinder wall 2b.

As shown in Figure 2 the frangible wall portion R is created by providing a flat on the inner wall W but it will be appreciated that many other forms of frangible wall portions may be provided (for example a grooved or necked area or other forms of local thinning or weakening of the inner wall W could be provided). Since the single pressure relief safety device as aforedescribed can effectively replace the three pressure relief devices described, for example, in the aforementioned application WO 82/03441 the closure member can advantageously be made to a size such as 17 mm diameter whilst not

precluding its use in containers of up to 100 mm diameter or more.

Additionally, it is also a significant advantage for the design of container as depicted in Figures 1 and 2 that it is basically in two parts (namely the tubular member 2 and closure member 3). This two-part construction of the container (rather than a one-piece integrally formed container) allows for much greater versatility in design. As shown in Figure 1 the dome 3b of the closure 3 carries a poppet valve 4 and the various parts thereof have been introduced into head H of the dome 3b from the inside of the dome. Thus, a remarkably simple valve construction can be provided utilising a minimum number of parts and in a very inexpensive way. The poppet valve 4 is integrated into the head H so that the head H itself provides the housing for valve poppet 4a. Poppet 4a is seated in receiving cup 4b which is spring-loaded by helically coiled compression spring 4c into contact with valve seat 4d formed on the head H. Spring 4c bears against retaining plate 4e in a manner which should be evident from Figure 1 and the other drawings (see e.g. Figure 6).

The design of the container 1 may be modified, for example so that the closure member 3 mechanically interlocks with the tubular member 2 rather than being welded thereto and/or the poppet valve 4 may be replaced by other valve means, for example by a frangible wall portion depending upon the use of the container.

Accordingly, Figure 3 shows a second embodiment of the present invention in which the poppet valve 4 has been replaced by a frangible wall portion Z of thickness 1 mm or so which may be

punctured by a piercing pin (not shown) in order to discharge the contents of the container 1'. Additionally, the closure member 3' is attached to the tubular member 2' by an engaging beaded lip 2'a (or alternatively by an engaging lip 2'b of different form) engaging with external peripheral projection or projections on the closure member 3. Lip 2'a is inwardly bent and outwardly folded and lip 2'b inwardly folded. The closure member 3 may be attached to the tubular member 2 by any one of a variety of ways such as crimping or swaging. The lip closing operations may rely upon a deformation of the lip (2'a, 2'b) and, for this reason, the material of the tubular member 2' in the region of the lip is required to exhibit an elongation before cracking or fracture of about 7% and preferably of 10% or more, in order to facilitate the lip closing operation. In this embodiment, the radial width of the annular gap G is 2.25 mm and the length of the tubular part of the closure member 3' is 30 mm.

Figure 4 shows a third embodiment of the present invention in which the closure member 3" is of high impact plastics and the tubular member 2" is of a metal alloy. In this embodiment, the closure member 3" is inserted into the open end of the tubular member 2" and the tubular member is introduced into a die to press the tubular member 2" firmly onto the closure member 3". Four circumferentially spaced axially extending venting grooves V are provided leading from the annular gap G". As shown a thickened band B is provided on the outside of inner wall portion W of the closure member 3" and this engages in an inner recessed portion D of the interior of wall 2"b of tubular cylindrical member 2".

Figure 5 shows a fourth embodiment of the present invention in which a closure member 203 is screwed onto a tubular member 202 and axial venting grooves V are provided spaced around the axis of a container 201 leading from the annular gap G as shown. A bursting dome 204 is provided (advantageously this is moulded into the closure member 203) instead of poppet valve 4 (as shown in Figure 1) and a rear restricter or plug 205 is inserted in position as shown from inside the dome 204. This provides a cheaper alternative to a poppet valve and different flow rates may be provided for by selecting restrictors with differently sized venting holes.

Figure 6 shows a fifth preferred form of the present invention encompassing inventive features from the various embodiments described. As shown, the closure member 403 consists basically of two parts, namely an outer plastics tubular shell 404 and an inner metal lining 405 which may simply be an inexpensive pressing. The closure member 403 has been introduced into an alloy tubular member 402 and retained in place by a locking ring r. The closure member 403 is inserted into the tubular member 402 axially beyond the position shown. Then the locking ring r, which is preferably a split metal ring, is inserted into the open end of the tubular member 402 and when it reaches the inner groove in the tubular member 402 it expands outwardly to seat inside the groove. The closure member 403 is thus allowed to move axially outwardly from the tubular member 402 until an angled bead thereon seats against the inclined edge of the locking ring r. Thus, the locking ring r acts as a wedge preventing further axial outward movement of the closure member 403.

The angle of the bead matches the angle of the inclined edge of the locking ring r and this angle is preferably 25° to the vertical (radial plane) but may be between 5° and 50°. The locking ring r is arranged to locate some distance from the open end of the tubular member 402 and this length of the cylindrical wall of the tubular member 402 provides an additional load bearing member to resist expansion of the plastics in order to share the load. The modulus of elasticity of the closure member 403 is preferably about 1/7 of the modulus of elasticity of the tubular member 402. In this embodiment, the closure member 403 is provided with a poppet valve 406 and there is no continuous annular gap G formed all the way around the inner wall W provided by the closure member 403. Instead a gap 407 is provided locally by a cut-away area of the plastics of the closure member shell 404 in such a way that under high pressure the area of the metal lining 405 underlying the gap 407 is allowed to expand into the gap 407 until it bursts allowing pressure to vent to atmosphere via the four equiangularly spaced grooves V leading from the gap 407 to atmosphere. Advantageously, in this arrangement since the plastics shell 404 of the closure member is shielded from direct fluid pressure by the lining 405 said plastics material can be produced to a lower grade cheaper specification (i.e. the plastics need not be high strength plastics).

Figure 7 shows a sixth embodiment of a fluid container 501 comprising a body or tubular member 502 made of metal and closed at a first end by a bottom and at a second end by a closure member 503 made of plastics. The tubular member 502 is, on the inner side of the second end, roughened, for

example, by way of a plurality of grooves 502'. Typically the grooves 502' are 0.8 mm deep 1.2 mm wide and with a pitch of 1.6 mm. The closure member 503 has a tubular part 503a a substantial portion of which is located inside the tubular member 502. The tubular part 503a has an inner end situated inside the tubular member 502 which is provided with an annular end shoulder S provided with a groove which receives an O-ring for sealing against the inside of the tubular member 502. The outer end of the tubular part 503a is situated outside the tubular member 502 with e.g. 0.6 mm interference and has a domed top 503b provided with a head H which carries a centrally located poppet or aerosol valve 504 arranged on the axis of the tubular member 502. An outer annular shoulder 506 providing a flange is formed at the portion of the domed top 503b remote from the head H. An annular gap G is defined between the tubular part 503a and the tubular member 502. The gap G is closed at one end by the shoulder S with the O-ring and communicates by vents 505 with the atmosphere. Each of the vents 505 is composed of an axial vent groove opening into a radial vent groove which is situated in the flange of the shoulder 506 and opens into the atmosphere. The radial grooves should have a significantly smaller cross-sectional area than the axial grooves which feed them so that they act as bottle necks and thus cause a pressure build-up in the long axial groove so as to prevent the carbon dioxide from becoming solid as explained above. In a typical example the axial grooves may be about 1.5 mm deep and 2 mm wide, while the radial grooves will be

about 0.3 mm to 0.5 mm deep and 0.3 mm to 0.5 mm wide. Naturally the cross-sectional area will depen on the number of grooves provided in any particular embodiment and on the gas stored in the container. localised region R of the tubular part 503a is of reduced thickness and is designed to burst at a particular safety pressure as described earlier. The tubular member 502 and the closure member 503 are attached together preferably by ultrasonic vibratior which causes the plastics material of the closure member 503 to be partly melted or reformed so as to flow into the grooves 502' and set therein. Suitab: machines are available for instance from Forward Ultrasonics Limited which is a subsidiary of Megasonics S.A. (France) and Herfurth UK Limited, which is a subsidiary of Herfurth GmbH (Federal Republic of Germany). The machine is rated at 2-3 and a suitable frequency is about 20 kHz the dwell time being approximately 1 second. The vibration transmitting element of the machine is pressed in operation on to the shoulder 506. An alternative i to heat the open end of the tubular member 502, e.g by induction heating, flame jets, laser, or in the oven, above the melting point of the plastics and then press the closure member 503 into the tubular member 502. Another possibility is to heat the tubular member 502 to e.g. 500°C, chill the closure member 503 to e.g. -150°C, bring the two members together and allow the hot tubular member 502 to shrink onto the cold closure member 503 thus causi partly melting and partly reforming of the plastic which thereby enters into the grooves.

At least one of the tubular members or closure members may alternatively be of a material or coated with a material, such as a plastics

material, which is soft at room temperature or when heated to enable that member to be deformed to attach the members. Instead of a screw thread, the connection may alternatively be by a means such as one or more ribs or protrusions. The ribs or protrusions may be saw-teeth and may be on the inside of the tubular member and/or on the outside of the closure member. They are preferably arranged, by choosing the pitch or otherwise, such that there is little ratcheting effect, ie so that the ends of the teeth do not properly engage until the member is almost completely home to avoid undue wear on the ends of the teeth.

In one example the member may be heated at 100°C for 15 minutes, preferably by immersion in boiling water, which aids the softening. Other temperatures and heating periods may be used.

The O-ring is remotely located in the closure member 503 so as to avoid the adverse effects of the nearby heating of the tubular and/or closure members.

In the above embodiments of the invention there is provided a gap G which may be in the form of a single peripheral space or a plurality of peripheral spaces which communicate or communicates via suitable vents with the atmosphere and is at the inner end closed by an annular end shoulder S with the O-ring. This vented gap G then facilities the creation of a substantial pressure difference (e.g. of 50 MPa in the case of CO_2) so that the greater pressure inside the container acts radially outwardly on the tubular part of the closure member which improves the sealing and causes a situation wherein the greater the pressure in the container trying to blow it apart the harder it holds itself together because this pressure improves the seal or joint between the roughened inner surface of the tubular member and the closure member. This arrangement allows the thinned portion mentioned above to act as

a pressure-bursting diaphragm.

In the aforedescribed embodiments none of the vents pierces the end wall of the closure member and so, advantageously, there is no necessity for a top shroud (as with the arrangement depicted in application WO 82/03441) to prevent tampering with the pressure relief devices. Obviation of the need for a top shroud reduces the overall cost and weight of the item and tends to increase reliability. The cross-sectional area of the vents is such that when the frangible inner wall portion has burst, the pressure in the gap between the tubular part and the tubular member remains substantially above 60.4 p.s.i.g. (415 kPa) i.e. the pressure below which solid CO_2 can form, thus avoiding possible blocking of the vents by the presence of solid material.

With all the aforedescribed containers, advantageously, a single two-stage proof test can be applied. With a container of minimum burst pressure of 3000 p.s.i.g. (20684 kPa), proof-testing is usually done at 2000 p.s.i.g. (13790 kPa). Thus, the container can be tested firstly with a 2000 p.s.i.g. (13790 kPa) internal pressure and with a 500 p.s.i.g. (3447 kPa) offset pressure applied to the annular gap (through the vents) between the inner wall and the container wall. Therefore, the inner wall is tested to a pressure difference of 1500 p.s.i.g. (10342 kPa). Then the offset pressure is increased to 2000 p.s.i.g. (13790 kPa) and this tests the container wall. Thus, the container can be thoroughly proof-tested.

With the above embodiments, excess pressure of the container's contents is relieved by fracturing of the frangible portions, which allows the contents to be relieved relatively gently through the passages

and vent orifices. In a preferred embodiment, two vent orifices are included, mounted diametrically opposite one another to cancel any undesired jet reaction. In some embodiments the vents are designed to empty the contents of a cylinder relatively slowly, for example 300 gram of contents at about 10-20 grams per second. However, this rate of release may not be quick enough in severe circumstances such as the cylinder being caught in a fire, in which case the pressure may rise dangerously and possibly cause a catastrophic explosion of the container.

Figure 8 shows a modified apparatus which attempts to solve this problem. The cylinder head includes a small bore housing a valve poppet 604 and valve spring 605, and a larger bore in which is secured a valve plug 606, retained by two snap ridges 607. The valve plug includes slots in both the axial and radial directions to enable rapid refilling and venting. The (lefthand) end of the larger bore nearest the top of the cylinder has a sharp corner 608 which aligns obliquely with the sharp corner 609 of an undercut 610 provided at the lower end of the cylinder's coupling thread 611. The sharp corners induce a stress concentration when the cylinder is under pressure, which causes an incipient fracture path between them. Any other means of inducing a stress concentration leading to an incipient fracture path may alternatively be used.

In use, in an extreme situation, if the frangible part of parts of a cylinder have ruptured but are unable to relieve the gas pressure quickly enough then the neck will fracture along the path between corners 608 and 609. This causes the valve plug 606 to experience a large force (typically 2500

N) leftwards in the figure, moving it to abut against the domed inner wall 612. In this position, the radial slots 613 through which the cylinder is refilled and vented are blocked off. Thus, the container contents can only discharge through the small axial discharge orifice 614, the size of which is chosen for a selected rate of discharge. Typically, it is from 0.6 to 1.5 mm diameter, allowing discharge rates of 30 to 180 grams per second for example.

The top part of the cylinder head will of course, be explosively released after fracture, but the energy of this is small, since it is only due to the smaller volume of gas contained in the voids to the left (in the Figure) of the valve plug flange. The energy of release may be for example 20 Joules, compared to the 14,000 Joules which would be released if a cylinder exploded catastrophically. This will be followed by a safe, slow, release of gas to empty the cylinder.

The embodiment of Figure 8 also protects against other situations. For example, when the cylinder is screwed into the socket of an appliance (such as a pressurised drinks maker or a tyre unflater) an accidential large sideways force could cause a dangerous breakage of an unprotected cylinder. With the present embodiment, the neck may fracture controllably between corners 608 and 609, leading to a small controlled explosive release of gas (of for example 20 Joules as above), followed by a substantially safe discharge.

CLAIMS

1. A fluid container for containing a fluid under pressure, comprising a tubular member closed by a closure member, said closure member having a tubular part extending generally axially within the tubular member to form at least one peripheral space between the closure member and tubular member, the space being sealed from the inside of the container and having at least one vent passage leading from the space to outside the container.

2. A fluid container as claimed in Claim 1 wherein the peripheral space is sealed from the inside of the container by peripheral sealing means at the end towards the bottom of the container and from the outside, except for the or each vent, by a joint at the top end of the container between the closure member and tubular member.

3. A fluid container as claimed in Claim 1 or Claim 2 including a pressure-relief safety device in the form of at least one frangible wall portion of said tubular part, said frangible wall portion being arranged to break in the event that the pressure in the container exceeds a pre-determined safety limit.

4. A fluid container as claimed in Claim 1, 2, or 3 wherein the tubular part of the closure member is generally coaxial with the tubular member and has at least one localised region having a wall thickness which is thinner than the remainder of the tubular part such that under increasing pressure in the fluid container the thin wall portion is able to bulge into the peripheral space until it breaks and allows pressure to vent to atmosphere.

5. A fluid container as claimed in any one of Claims 1 to 4, wherein the peripheral space and vent or vents are designed such that the fluid pressure in

the gap is substantially maintained above the level below which a chosen escaping fluid may form the solid phase.

6. A fluid container as claimed in Claim 5 wherein the or each vent comprises an axial vent groove opening into a radial vent groove which is open to the atmosphere, the or each radial groove having a smaller cross-sectional area than the axial groove which feeds it, so that it acts as a bottle neck to cause the pressure in the axial groove to be maintained above the level below which the chosen escaping fluid may form the solid phase.

7. A fluid container as claimed in any preceding claim wherein the tubular member and closure member are mechanically interlocked at a joint.

8. A fluid container as claimed in Claim 7 wherein the mating surfaces of the joint between the tubular member and the closure member are provided with serrated ridges and grooves which cooperate to provide the joint.

9. A fluid container as claimed in Claim 7 wherein the mating surfaces of the tubular member and the closure member are screw-threadedly engaged to provide the joint.

10. A fluid container as claimed in any of the Claims 1 to 5 wherein the tubular member and closure member are non-mechanically bonded at a joint.

11. A fluid container as claimed in Claim 10 wherein at least one of the tubular member and closure member are deformable to provide the joint.

12. A fluid container as claimed in any one of the preceding claims, wherein the closure member includes an annular shoulder attached to the tubular part, the tubular member or tubular part having lands

formed thereon to restrain the closure member from being displaced out of the tubular member.

13. A fluid container as claimed in Claim 1 wherein the closure member includes a displaceable valve plug having an orifice of chosen size and a forward portion adapted to fracture in the event that the pressure in the container exceeds a threshold limit, the valve plug being adapted to close upon fracture of the forward portion to allow controlled discharge of the contents of the container through its orifice.

14. A fluid container for containing a fluid under pressure, comprising a tubular member and a closure member wherein the closure member includes a displaceable valve plug having an orifice of chosen size and a forward portion adapted to fracture in the event that the pressure in the container exceeds a threshold limit, the valve plug being adapted to close upon fracture of the forward portion to allow controlled discharge of the contents of the container through its orifice.

15. A fluid container as claimed in Claim 13 or Claim 14 wherein the closure member has first and second axially spaced bores, the valve plug acting to close the second bore.

16. A fluid container as claimed in Claim 15, wherein the forward portion is adapted to be released in the event of a fracture, under the pressure of gas contained in the first bore only.

17. A fluid container as claimed in any of Claims 13 to 16 wherein the forward portion is adapted to fracture upon a predetermined lateral force.

18. A fluid container as claimed in any of Claims 13 to 17 wherein the closure member has a

profile which induces stress concentrations on at least one internal and external surface, to create an incipient fracture path.

19. A fluid container as claimed in any preceding claim, wherein the elastic modulus of the material of the closure member is substantially lower than the elastic modulus of the material of the tubular member.

20. A fluid container for containing a fluid under pressure, comprising a tubular member which receives a closure member, said closure member being sealed to the tubular member, said container being provided with a pressure-relief safety device in the form of at least one frangible wall portion of an inner wall arranged generally axially of the container, said wall portion being arranged to break in the event that the pressure in the container exceeds a preset safety limit.

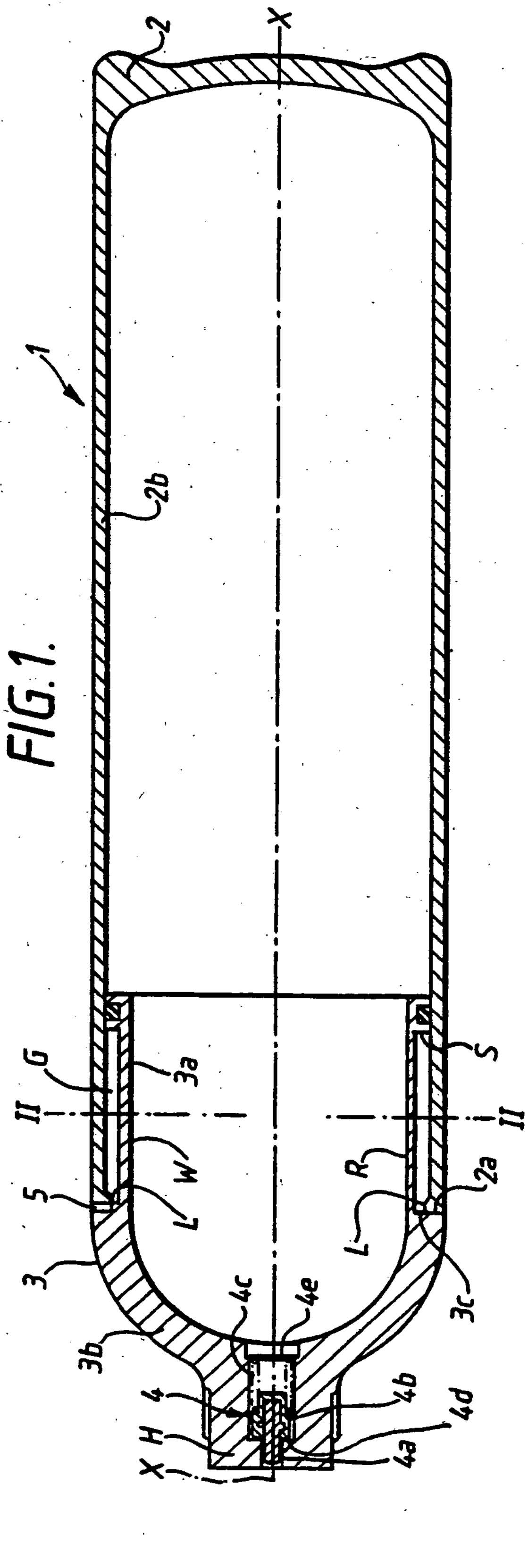


FIG.1.

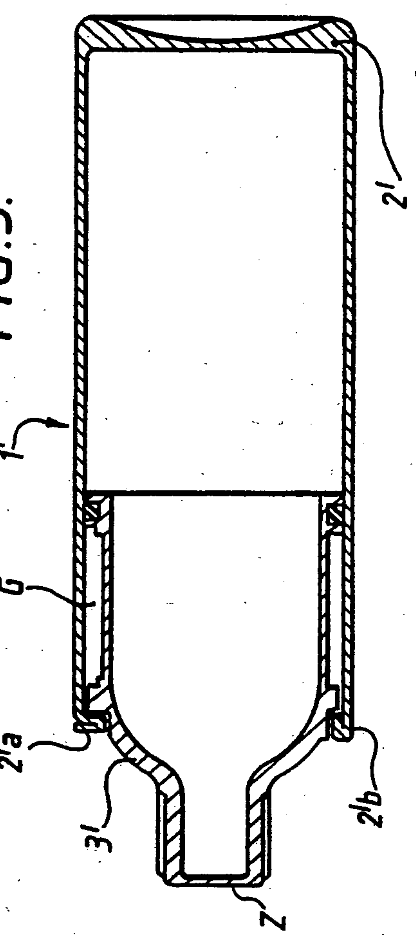


FIG.3.

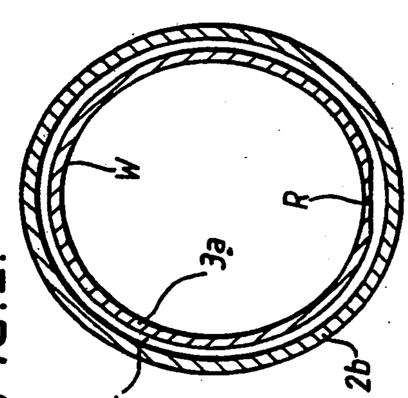


FIG.2.

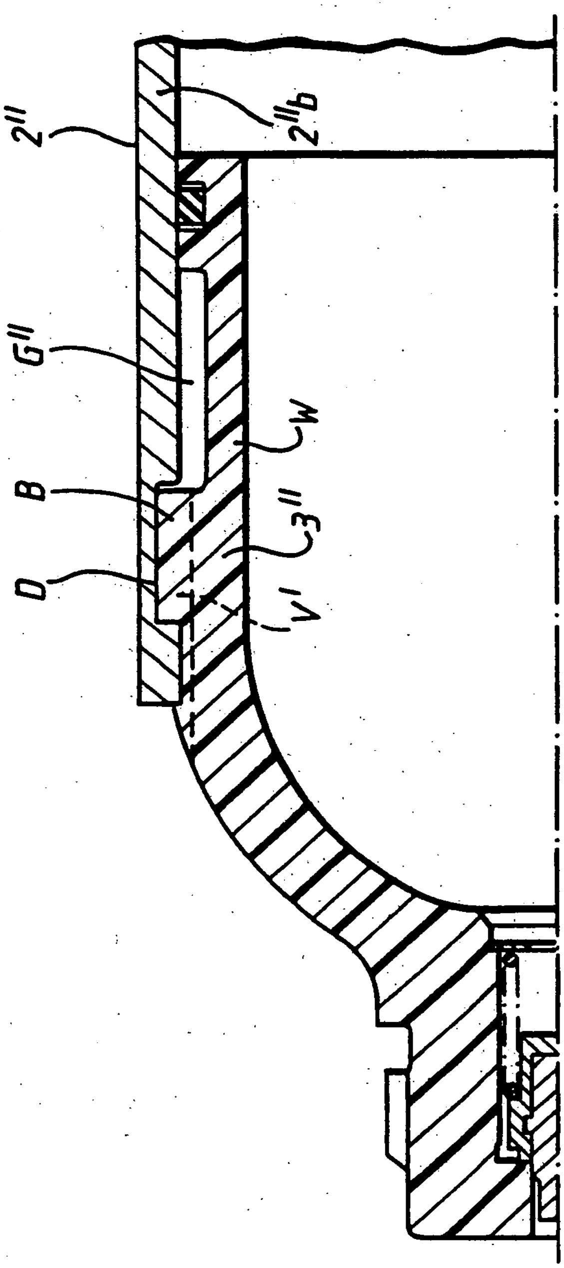


FIG.4.

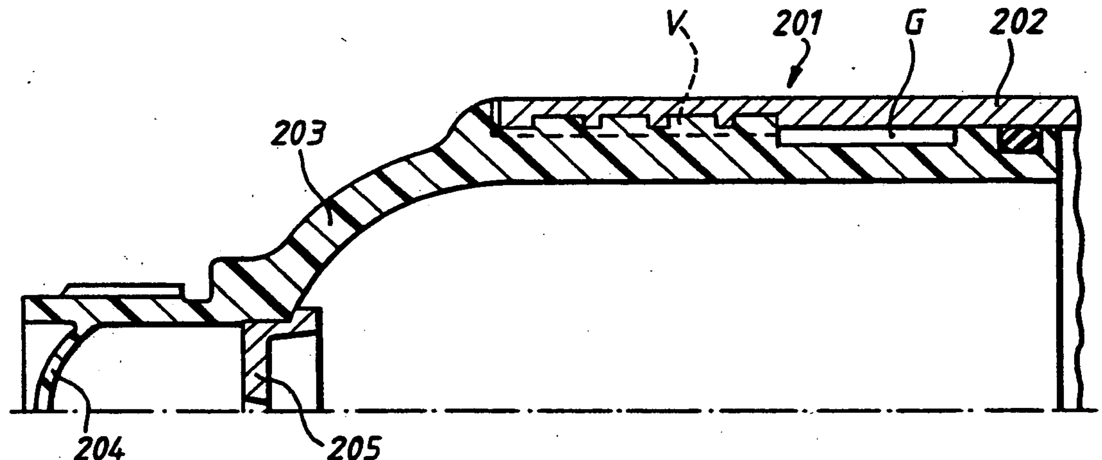


FIG.5.

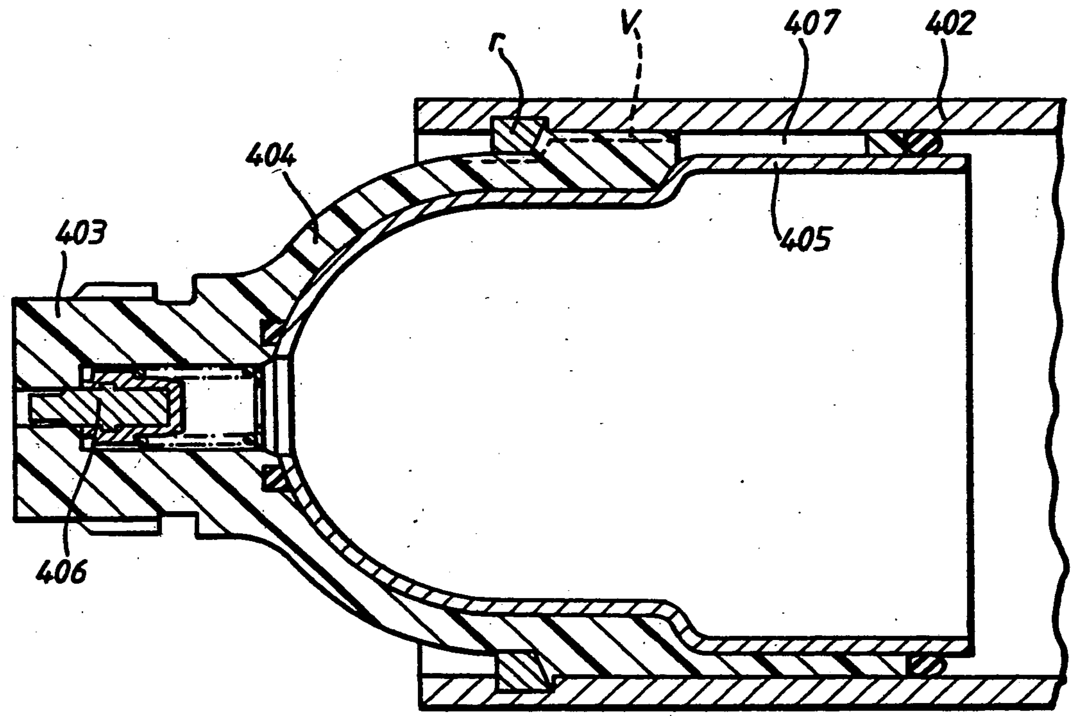
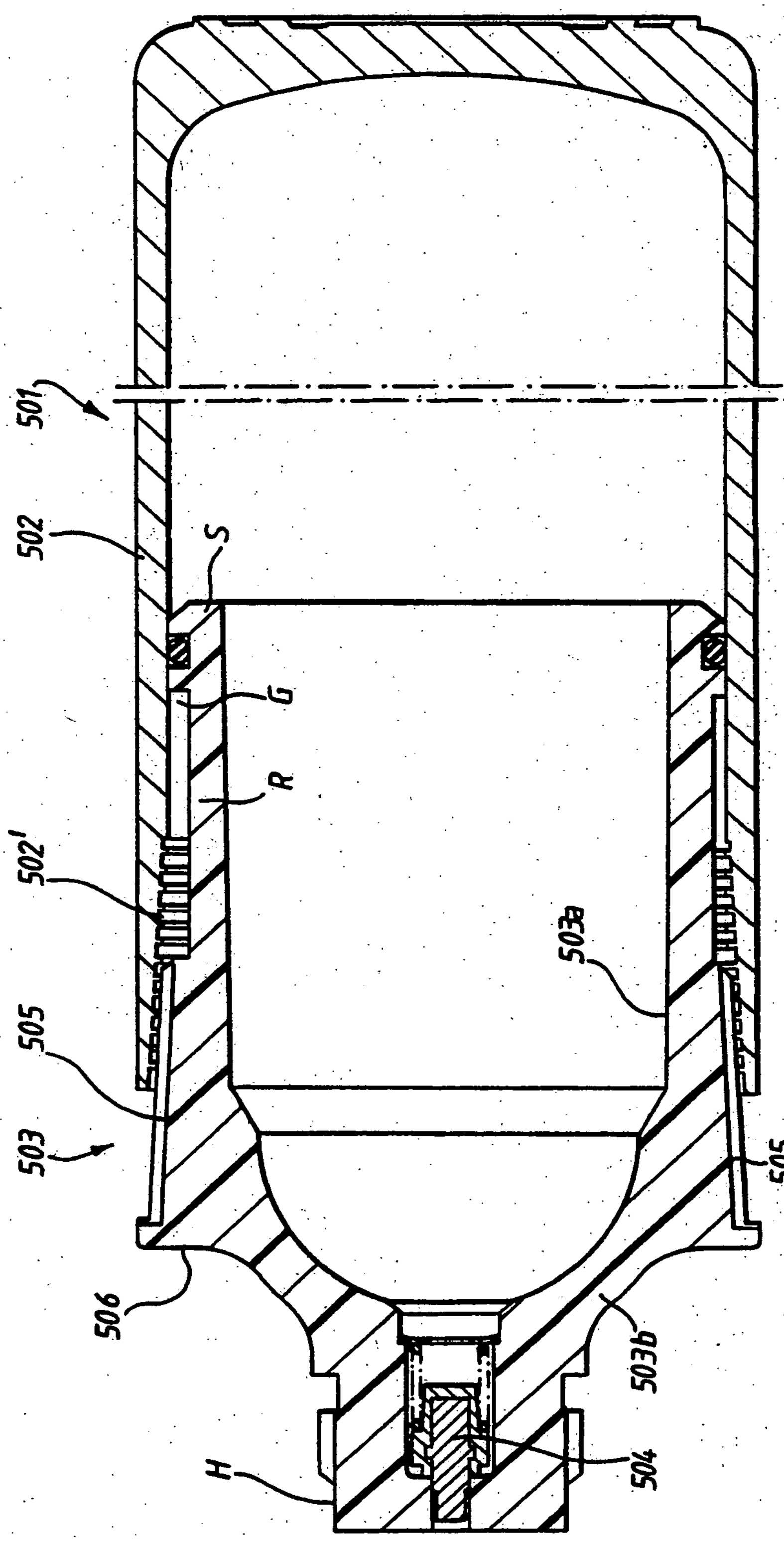


FIG.6.

FIG. 7.



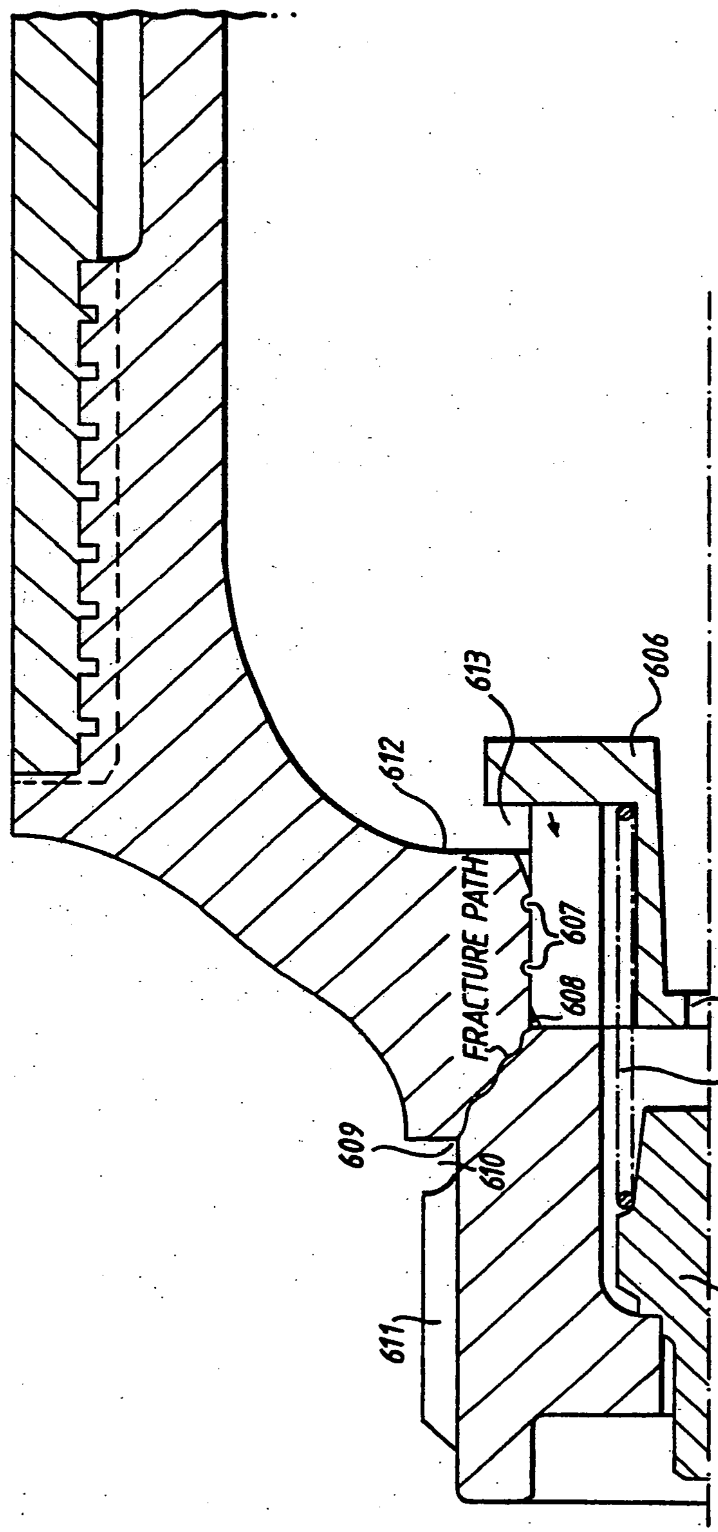


FIG.8.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/02178

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F17C1/14; F17C1/16; F17C13/12; F17C13/10

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F17C ; B65D ; A62C ; B21D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	WORLD PATENTS INDEX Section Ch, Derwent Publications Ltd., London, GB; Class A, AN 68-05362Q see abstract & NL,A,6615911 (ORSZAGOS KöOLAJ ES GAZIPARI TROSZT) 13 May 1968 (13.05.68) see page 3, lines 14-21 see page 5, lines 17-22 see figure 2 see claim 1 ---	1,10
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 455 (M-879)(3803) 13 October 1989 & JP,A,1 176 898 (HONDA MOTOR CO., LTD.) 13 July 1989 see abstract; figure ---	1

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° Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
03 MARCH 1992	25. 03. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	STEVNSBORG N.

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International Application No PCT/GB 91/02178

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,3 095 993 (G.A.BALCOM ET AL.) 2 July 1963 see column 1, line 9 - line 12 see column 1, line 27 - line 45 see column 1, line 63 - line 70 see column 2, line 22 - line 57 see column 3, line 26 - line 32 see claim 1; figures 1,3,4 ---	1,2,4,10
A	EP,A,0 231 745 (J.W.RILETT) 12 August 1987 cited in the application see abstract see page 27, line 10 - line 12 see page 32, line 1 - page 33, line 2 see page 36, line 12 - line 20 see page 40, line 4 - page 41, line 7 see page 42, line 25 - page 43, line 11 see figure 1 & WO,A,82/03441 (J.W.RILETT) 14 OCTOBER 1982 (14.10.82) ---	1,6-8, 11,12
A	US,A,2 895 633 (C.ZELLWEGER) 21 July 1959 see column 1, line 15 - line 17 see column 1, line 46 - line 71 see column 2, line 6 - line 52 see column 2, line 66 - column 3, line 7 see figures 1,2 ---	1,3
A	US,A,4 077 422 (R.G.BRINKLEY ET AL.) 7 March 1978 see abstract see column 1, line 56 - column 2, line 17 see column 3, line 20 - column 5, line 8 see figures 1-4 ---	13,14, 17,18

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9102178
SA 54092

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-3095993		None		
EP-A-0231745	12-08-87	AU-A-	8277982	19-10-82
		EP-A,B	0075572	06-04-83
		WO-A-	8203441	14-10-82
		GB-A,B	2096299	13-10-82
		US-A-	4854343	08-08-89
US-A-2895633		None		
US-A-4077422	07-03-78	None		

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82